characterized by the fact that their viscosities change dramatically with shear rate. Changes in injection rate or gate size can impact viscosity and thus cavity fill rate and the cavity pressure gradient. Additionally, materials vary in viscosity from lot to lot when manufactured and can degrade with the presence of moisture or excess temperature. Thus it is important to take advantage of this shear thinning to modify the rheology from lot to lot to a specific target value. Consequently, when all the parameters, such as the fill rate and injection pressure are set the same, parts can vary dramatically from lot to lot. As explained in the background, due to the nature of long chain molecules and the polymerization process, there are inherently large variations in the process even when machine conditions are held constant. However, variables such as pressure, temperature, flow rate and cooling rate do influence the properties of the phase change material which correlate to the finished part properties. By monitoring these variables, part characteristics can be accurately and consistently predicted.

Each of the variables of the plastic injection molding process directly or indirectly affect other variables which account for most variations in the finished part. For instance, changing the barrel temperature on an injection molding machine would also affect the ability of the material to transmit pressure into the mold, and thus the plastic pressure is changed. As the material is heated, it becomes less viscous and thus the flow rate increases. Also, by increasing the temperature the cooling rate is affected, since the cooling rate is a function of plastic temperature and mold temperature. Thus the injection molded variables are not well isolated or controlled.

Mold cavity pressure, however, has been found to be the most important indicator of molded part dimensions and weight. Plastic pressure in the mold cavity, however, cannot be expressed as a single figure for the mold, but rather as a profile across the mold cavity. This profile begins at the beginning-of-fill point and continues to the end-of-fill point. The flow restriction caused by the mold cavity and insert geometry cause a pressure drop between the first and last areas to fill with plastic. Thus the pressure is slightly different at different points in the mold cavity. This gradient can cause non-uniformity of the phase change material across the mold cavity. Uniformity of the properties of the phase change material is critical to obtaining a reproducible resonance spectrum. Therefore it is important to ensure that the pressure gradient inside the cavity is minimized and is reproducible for each shot.

It has been found that using pressure transducers at the beginning-of-fill and end-of-fill points and measuring the injection rate can provide a basis for intelligent decision making when coupled with monitoring of the injection pressure and fill rate in the injection molding machine. With these four readings, one can determine the pressure gradient across the system and can alter other system variables to obtain a target pressure profile across the mold cavity.

The pressure profile in the mold derived from transducers at the beginning-of-fill and at the end-of-fill points provide the greatest degree of insight into part quality. Because plastic is compressible at one half to three quarters of a percent per thousand PSI, this cavity pressure profile gives a measure of how the plastic is compressed across the mold. After post-mold stabilization, which occurs

sometime between 6 hours to 6 days after the part is removed from the mold, parts achieve constant density. Because material density varies across the mold prior to stabilization, due to the pressure profile, stabilized parts will change size in varying amounts across the part in order to reach their stable constant densities. If the pressure profile is kept uniform from part to part, the density of the plastic is also quite uniform from part to part. This maintains the desired shape of the plastic after stabilization and also retains its predicted spectrum of resonance after stabilization for each part. Thus, in order to obtain a uniform pressure profile, the pressure is preferably measured at the end-of-fill point until it reaches a pre-determined set point pressure. At that point the flow rate is decreased and the molten material is held inside the cavity at the pre-determined set point pressure to obtain a target pressure profile inside the cavity and allowed to cool and solidify.

The cavity pressure profile is influenced by not only the injection pressure applied by the injection molding machine, but also by the fill time, temperature of the plastic and temperature of the mold. In a preferred embodiment, the fill time is also monitored and controlled to keep a constant viscosity of the molten phase change material. The preferred fill time can be determined by comparing fill times of parts known to be good during initial quality control studies on the mold. Cavity pressure profile with fill time held constant is a function of the apparent viscosity of the material, the melt temperature, and the mold temperature. The temperature can be monitored and controlled through the use of thermocouples. Due to the non-newtonian characteristics of plastic, the fill time is preferably kept relatively low, for example less than a second, with a high flow rate to decrease